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Patent claims

5 1. A method for controlling the power supply of a mobile device having at least one electric drive motor and a hybrid power supply system which has a fuel cell system and a dynamic power system, wherein the electrical outputs of the fuel cell system are
10 connected to one side of a power converter whose other side feeds the drive motor which is controlled by a motor control unit, and wherein the dynamic power system has a storage battery which is connected to one side of a d.c./d.c transformer whose other side is
15 connected to the electrical outputs of the fuel cell system and to one side of the power converter, characterized in that signals which are generated by a signal transmitter for requesting the setpoint power of the drive motor, a signal which is output by an
20 operating mode switch with a plurality of selectable settings which are each assigned to different types of dynamic behavior of the device, emitted values of a power sensor for the output current and emitted values of a voltage sensor for the output voltage of the fuel
25 cell and emitted values of a sensor for the velocity of the device are processed in order to determine the power components in the requested setpoint power which are to be provided by the fuel cell system and by the dynamic power system, in such a way that when there is
30 a change in the setpoint power the difference between the partial power which can be generated by the fuel cell system with a delay according to the transition function and the setpoint power is generated by the storage battery of the dynamic power system by applying
35 corresponding setpoint values to the d.c./d.c. transformer, with reference to the power of the drive motor which has already been output and the power of the fuel cell system which has already been generated as well as the velocity of the device, taking into

account the selected type of dynamic behavior and the different transition functions of the fuel cell system and of the dynamic power system.

- 5 2. The method as claimed in claim 1, characterized in that, in the case of a sudden increase or decrease in the setpoint power, the increase or decrease in the current flowing out of or into the storage battery via the d.c./d.c. converter - said increase or decrease
10 being necessary for the increase or decrease in the additional power - is limited to a maximum prescribable charge current or a maximum prescribable discharge current.
- 15 3. The method as claimed in claim 1 or 2, characterized in that from a vehicle control unit of the mobile device load current values of the further loads in the device are superimposed on the power demand values for the drive motor and fed, with a
20 charge current value generated when necessary by a battery management system, to a power control unit with limitation to a fuel cell maximum power value of a power control unit, to which power control unit device for velocity values, torque setpoint values from a
25 setpoint value signal transmitter, battery charge state values and values of an operating mode selector switch for setting various types of dynamic behavior are fed to the mobile device, and which calculates, as a function of the fed values, the values of the overall
30 power demand and of the power demand which is to be contributed by the fuel cell system taking into account its inertia behavior and the selected dynamic behavior, and outputs corresponding setpoint values to the actuating elements of the fuel cell system, and in that
35 in each case the values of the current which is output by the fuel cell is determined, subtracted from the value of the current required by the drive motor, and are fed as current setpoint values to the d.c./d.c. transformer with limitation to a maximum specifiabile

discharge current or charge current of the storage battery.

4. The method as claimed in claim 1 or 2,
5 characterized in that the sum of the value of the
current which is respectively drawn from the drive
motor via the power converter and values of the
currents which are drawn from the other loads of the
device are subtracted from the value of the current
10 which is output by the fuel cell, and when a maximum
predefinable value of the discharge current of the
storage battery is reached it is limited to its
discharge current, and in that the result of the
difference between the currents which are drawn from
15 the further loads is added to the value of the
available fuel cell current and signaled to the control
unit of the device as an available value of the
current.

20 5. The method as claimed in at least one of the
preceding claims, characterized in that the transition
function of the fuel cell system is simulated as a
controlled system using a memory element of the n-th
order, in that the torque setpoint values which are
25 output by the vehicle control unit of the mobile device
are applied to the memory element and to a control unit
for the dynamic power system, in that the values which
are generated according to the transition function of
the controlled system are additionally fed to the
30 control unit, and in that the current which is to be
applied by the dynamic power system can be fed as a
current setpoint value to the d.c./d.c. transformer by
the control unit by means of a limiter element which
can be set to at least two ramps with different
35 gradients as a function of control signals from the
device.

6. The method as claimed in at least one of the
preceding claims, characterized in that, during the

duration of an acceleration process of the device, during which the setpoint torque is determined by the vehicle control unit by pilot control and a maximum current for the generation of the setpoint torque is
5 determined from a characteristic diagram with the torque as a function of the maximum current and the rotational speed, the difference between the current which is generated by the fuel cell system during the acceleration process and the overall current which is
10 required by the dynamic power system according to the characteristic diagram in order to achieve the high acceleration is generated.

7. The method as claimed in at least one of the
15 preceding claims, characterized in that when there is a reduction in the setpoint torque to be output by the drive motor the current which is necessary for the lower torque is determined from the characteristic diagram, and in that with reference to the respective
20 load state of the fuel cell system given the preset torque setpoint value and the existing storage capacity of the storage battery, the latter is charged with the maximum prescribable charge current by means of the d.c./d.c. transformer after the reversal of the flow of
25 current in the power converter in the braking mode of the drive motor and the fuel cell system is set to the current which is necessary for the lower setpoint torque.

8. The method as claimed in at least one of the
30 preceding claims, characterized in that the direction of the supply of combustion gas and air to the fuel cell is reversed periodically, and in that during the reversal of the supply of gas a current pulse which is
35 matched to the instantaneous output of current of the fuel cell system and/or of the dynamic power system directly before the changeover is fed in to the power converter by the dynamic power system via the d.c./d.c. transformer.

9. The method as claimed in at least one of the preceding claims, characterized in that the output voltage of the fuel cell system is monitored to
5 determine when a voltage limiting value which is permissible for satisfactory operation is reached or undershot, and in that when the voltage limiting value is reached or undershot, the voltage in the power system which is connected to the output of the fuel
10 cell is regulated to at least the permissible limiting value by feeding in current via the d.c./d.c. transformer.

10. The method as claimed in at least one of the preceding claims, characterized in that the load
15 situation of the power supply system during the intervention of the regulating process and the frequency of intervention of the voltage regulating process during the operation of the power supply system
20 are registered, and in that after a predefinable number of interventions have been exceeded the dynamics are reduced by reducing the rate of increase in the current of the fuel cell system and/or the dynamic power system and the magnitude of the power which is output.

25 11. The method as claimed in at least one of the preceding claims, characterized in that the rate of increase in the output power of the fuel cell system given sufficient storage battery charge when the torque
30 setpoint value is increased is limited, and in that the current which is necessary to generate the torque setpoint value is generated by the dynamic power system during the increase.

35 12. The method as claimed in at least one of the preceding claims, characterized in that at least three operating modes for the drive motor can be set by means of the operating mode selector switch, one operating mode of which is aimed at a high level of dynamics of

the device, a second of which is aimed at a low level of dynamics of the device and a fourth of which is aimed at a stop and go operating mode, and in that when accelerations occur in the stop and go operating mode
5 currents are generated by the dynamic power system and stored therein during braking.

13. The method as claimed in at least one of the preceding claims, characterized in that the portion of
10 the current to be applied by the dynamic power system which is formed by the current necessary to generate a requested drive power with the respectively existing actual value of the current consumed by the device and the current available from the fuel cell system is
15 determined.

14. The method as claimed in at least one of the preceding claims, characterized in that an emergency operating mode of the power supply system is ensured by
20 a voltage regulating process in the power system at the input of the power converter by means of the d.c./d.c. transformer and feeding of the current from the storage battery.

25 15. An arrangement for controlling the power supply of a device having at least one electric drive motor and a hybrid power supply system which has a fuel cell system and a dynamic power system, wherein the electrical outputs of the fuel cell system are connected to one
30 side of a power converter whose other side feeds the drive motor which is controlled by a motor control unit, and wherein the dynamic power system has a storage battery which is connected to one side of a d.c./d.c converter whose other side is connected to the
35 electrical outputs of the fuel cell system and to one side of the power converter, characterized in that a vehicle control unit (18) which is connected to a velocity sensor of the mobile device (1) and to a signal transmitter (31) for a setpoint torque to be

generated by the drive motor is provided for setting the setpoint torque of an motor control unit (4) and for determining the current setpoint values for the mobile device (1) which are stored in a characteristic diagram for torque setpoint values and rotational speed values, in that the vehicle control unit (18) is connected to a power control unit (19) which is connected to the fuel cell system (7), a battery management system (12) for the storage battery (10) and to the d.c./d.c. transformer (9), in that the current which is output by the fuel cell of the fuel cell system (7) is measured and is fed as a fuel cell current value to the power control unit (19), in that the current of the drive motor is measured upstream of the power converter (3) and is fed as a driving current value to the power control unit (19), in that the current of the other loads are measured or calculated and fed to the power control unit (19) as a composite current value, in that an operating mode selector switch (50, 51, 52) for setting various operating modes of the power supply system is connected to the power control unit (19), in that values from the battery management system (12) relating to the charge state of the storage battery (10) and values relating to the maximum prescribable charge current and discharge current are fed to a power flux controller (38), and in that the power setpoint value, the fuel cell current value, the driving current value, the composite current value, the operating mode which is set, the charge state value and the maximum prescribed values of the charge current and discharge current are processed in the power control unit (19) and in the associated power flux controller (38) with one or more programs in such a way that when there is a change in the setpoint power the difference between the partial power which can be generated by the fuel cell system with a delay according to the transition function and the setpoint power is generated by the storage battery of the dynamic power system by applying corresponding setpoint

values to the d.c./d.c. transformer, with reference to the power of the drive motor which has already been output and the power of the fuel cell system which has already been generated as well as the velocity of the device, taking into account the selected type of dynamic behavior and the different transition functions of the fuel cell system and of the dynamic power system.

10 16. The arrangement as claimed in claim 15, characterized in that the mobile device is a motor vehicle for transporting persons and/or goods.

15 17. The arrangement as claimed in claim 15, characterized in that the device (1) is a forklift truck.